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DOCUMENT-IDENTIFIER: US [illegible] A
TITLE: Filter element and method for manufacture thereof and micro filtration filter having the filter element

Abstract Text (1):
A filter element includes unit members and spacers interposed one each between adjacent ones of the unit members. Each unit member includes a supporting plate having a pair of planar porous membranes joined to the [illegible] surfaces thereof and also having an opening for insertion of a spacer and [illegible]. The opening has an inner peripheral surface and a stepped part. Each spacer having an outer peripheral part and a stepped part. The stepped part of the opening of one unit member and the outer peripheral part of the spacer define a first axial seal part therebetween, and the inner peripheral [illegible] of the opening of another unit member and the stepped part of the [illegible] define a second axial seal part therebetween. The unit members and spacers are [illegible] by tightly joining the supporting plates and the spacers at the first and second axial seal parts. The filter element is manufactured by forming the first axial seal part by means of thermal fusion in the axial direction, forming the second axial seal part by means of thermal fusion in the axial direction, and repeating the formation of the first and second seal parts. A micro-filtration filter has the filter element accommodated therein.

Brief Summary Text (3):
The present invention relates to a filter element for removing minute particles from a raw fluid used in the industries of semiconductors, pharmaceuticals, chemicals, etc., such as a strongly acidic or basic fluid having high corrosiveness or reactivity, particularly an active fluid including an organic solvent, for example, also to a method for the manufacture of the filter element and further to a microfiltration filter having the filter element.

Brief Summary Text (5):
As for filter media, there have heretofore been known filter paper, filter cloth, filter net, nonwoven fabric and sintered articles. When the diameter of minute particles in a raw fluid is on the order of microns or submicrons falling within a so-called micro-filtration region, [illegible] membranes made of various polymers have been used. Since the porous membranes are thin films having a thickness in the range of from [illegible] and have a high porosity, they are very brittle [illegible] difficult to resist high pressure of filtration. For this reason, the [illegible] have been retained on a [illegible] support member in order to prevent their deformation [illegible] breakage and to form flow paths for the cleaned fluid. In addition, the porous membranes exhibit high precision of filtration, whereas they exhibit high resistance of filtration per unit area and are liable to clog. Therefore, the porous membranes are required to have a large area in comparison with the area of the aforementioned filter media ordinarily used.

Brief Summary Text (6):
In view of this and the recent tendency to miniaturization of a filter having a porous membrane, various constructions of such filters have been proposed.

Brief Summary Text (7):
For example, FIG. 1 illustrates a prior art pleat cartridge filter (hereinafter referred to simply as the "pleat type filter"), in which a porous membrane 1 and support members 2 intervening the porous membrane [illegible] therebetween are pleated and folded up. The folded up state of the porous membrane 1 and support members 2 is retained by an outer protective cylinder 3 and a [illegible] 4 [illegible] the [illegible] ends of the protective

[illegible] type filter having the
cylinder [illegible] are sealed [illegible] [illegible] cannot resist high pressure
construction described above [illegible] in that it [illegible] decreased due to the
of filtration, that the effective area [illegible] and that the [illegible] of pressure of filtration
presence of the area for an adhesive agent, and that the [illegible] of pressure of filtration
becomes large because the adjacent [illegible] of the pleated and folded up porous membrane
1 are close to each other.

Brief Summary Text (8):
FIGS. 2 and 3 illustrate prior art filters of a type in which a plurality of unit
members each having a support member laminated with a porous membrane are piled up
(hereinafter referred to simply as the "piled type filter"). In FIG. 2, a support
member 11 having a plurality of [illegible] for the cleaned fluid is
laminated with a porous membrane [illegible] and attached to the
support member 11 at both the outer periphery [illegible] and the
peripheral edge 14 of a cleaned fluid takeout opening, thereby forming a unit member
18, and a plurality of unit members [illegible] are piled up vertically at regular intervals in
a [illegible] In FIG. 3, reference numeral 7 designates a
[illegible] 11 a support member, 12 the outer periphery of the support
[illegible] peripheral edge of a cleaned fluid takeout opening, 17 a butt joint
portion, and 18 a unit member. The pileup type filter shown in FIG. 3 has a
construction substantially the same as that of the pileup type filter shown in FIG. 2
and has a plurality of unit members 18 piled up vertically at regular intervals in a
coupled state through the butt joint portions 17. These pileup type filters are free
from the aforementioned disadvantages of the pleat type filter.

Brief Summary Text (9):
The filters using a porous membrane have been developed, irrespective of the type
thereof, in order to filtrate a realtively inactive fluid, such as water, air,
nitrogen, etc. in the pharmaceutical and food industries and, therefore, the porous
membrane is made of cellulosic polymers including cellulose acetate and cellulose
nitrate, polyamide, polysulfone, polyvinyl chloride, polymethyl methacrylate, polyvinyl
alcohol, polycarbonate, polyethylene or polyvinylidene fluoride, for example. The
support member is molded of polystyrene, polycarbonate, polyacrylonitrile, polysulfone
or polypropylene, for example. Other members with which a fluid will come into contact,
such as a seal member, are formed of natural or synthetic rubber, polyurethane or
epoxy resin, for example.

Brief Summary Text (10):
With [illegible] of the industries requiring complete elimination of foreign matter,
[illegible] minute particles in a highly active fluid
[illegible] exhibiting high corrosiveness, a fluid
exhibiting high [illegible] and an organic solvent have been regarded as foreign matter
Recently, therefore, there is an increasing demand for the development of filters
capable of filtrating such a highly active fluids as described above in addition to a
comparatively inactive fluid including water and air. However, filters made of any of
the widely used polymers enumerated above cannot sufficiently deal with such an active
fluid from the standpoint of resistance to chemicals and solvents. Particularly when
fluids used in the etching and epitaxy processes in the manufacture of semiconductors
are to be filtrated, filters have to be made of a chemically stable material. For
example, fluorine resins and fluorine resin copolymers such as PTFE, PFA, EPE, FEP,
ETFE, PCTFE and ECTFE can be practically used effectively as a material for filters.
Thus, there is an increasing demand for the development of small-sized highly reliable
filters having a porous membrane, a support member, a seal member and any other
fluid-contacting member formed of a fluorine resin or fluorine resin copolymer so that
they do not suffer from any disadvantage when being brought into contact with a fluid.

Brief Summary Text (11):
In the meantime, it is one of the most important techniques for producing a filter
element of any type [illegible] flow path [illegible] raw fluid and for a cleaned
fluid are separated from each other with exactitude in order to prevent the raw fluid
[illegible] That is to say, means for sealing a
[illegible] the pleat type filters and,
[illegible] sealing a porous membrane and a
support member with exactitude is important.

Brief Summary Text (12):
As for the sealing means usable for constructing a filter element formed of any of the
aforementioned widely used polymers for filtrating an ordinary inactive fluid, there
can be adopted any one of the conventional general [illegible] sealing methods, such as the

hot press method, ultrasonic sealing method [illegible] and method using adhesives or sealants, for example. However, these general resin sealing methods are not effectively applicable to a filter element having all fluid contacting members thereof including a porous membrane formed of a fluorine resin or fluorine resin [illegible] a fluorine resin or fluorine resin [illegible] melting point, that it exhibits poor [illegible] melting point thereof, that it [illegible] chemically inactive. Due to the [illegible] physical and chemical properties of a fluorine resin or fluorine resin copolymer, it is very difficult to seal fluorine resins or fluorine resin copolymers together, or to seal a fluorine resin and a fluorine resin copolymer. In fact, there is little prior art disclosing an easy and reliable method for sealing them and no prior art disclosing an easy and reliable method for sealing a special portion of a specific shape, such as a portion of the pleat type filter to be sealed, portions of unit members constituting a filter element of the pileup type filter.

Brief Summary Text (13):
Therefore, it is considered that a thermal sealing method comprising the steps of heating surfaces of fluorine resins and of fluorine resin copolymers to be sealed uniformly as much as possible to temperatures higher than their melting points and thereafter immediately, preferably simultaneously, contacting the surfaces under pressure is a sole and relable means. However, since they are inferior in heat transmission property, the surfaces thereof to be sealed must be heated directly. This will raise a problem on how heat is given to the surfaces. Indirect heat generating methods, such as ultrasonic sealing method, vibration sealing method and rotation sealing method, [illegible] friction between the portions to be sealed will produce dust [illegible] of a filter requiring clearness of [illegible] by a flame or by blowing a [illegible] preferably simultaneously, pressed against each other.

Brief Summary Text (14):
Due to the recent tendency to miniaturization of a filter element of a pileup type filter, the thickness of a support member and the distance between adjacent support members must be made as small as possible. However, in Japanese Utility Model Public Disclosure No. 59-102111Japanese Patent Public Disclosures Nos. 56-129016, 58-98112 and 59-61323, it is very difficult to cause portions being sealed to adhere to each other under pressure by directly heating the portions from a gap between adjacent support members or from an opening of the support member in view of the shapes of the respectively disclosed support members. Therefore, it is necessary to adopt the second best method which comprises heating portions being sealed separately and causing the portions to adhere to each other under pressure as soon as possible after the heating step. However, very harsh conditions must be controlled in order to heat the portions being sealed uniformly without deforming the portions being sealed and without injuring porous membranes and portions having nothing to do with the sealing, and an exclusive special automatic machine is required in order to enhance the yield in a given process.

Brief Summary Text (15):
In [illegible] the aforementioned problems, the inventors have conducted various studies on conditions for sealing fluorine resins together and on shapes of the portions to be sealed. Generally, fluorine resins have a melting point in the range of 200 to 300 degrees centigrade which is higher than the melting points of the widely used resins, exhibit an inferior heat transmission property, and do not exhibit fluidity necessary for thermal adhesion even at temperatures higher than their respective melting points. For this reason, fluorine resins are inferior in thermal adhesion property even if they are of the same kind. Therefore, it has come to a conclusion that the thermal adhesion of fluorine resins is effected by heating the portions to be sealed at their surfaces, preferably to some depths thereof, at a predetermined temperature higher than the melting point to cause fluidity necessary for adhesion on the surfaces and thereafter immediately removing a heat source and contacting the surfaces under pressure and that more preferably the aforementioned heating is effected with the surfaces kept in contact with each other.

Brief Summary Text (16):
The support member for supporting [illegible] in a planar state as a filter medium for a single-layer [illegible] type filter has a [illegible] such that it has a plurality of [illegible] Japanese Patent Public Disclosure No. 56-129016, having [illegible] to support the

[illegible] communicating with an
whole of the filter medium and also has a plurality of [illegible] it is formed of a
outflow port for a cleaned filtrate or has a construction such that it is formed of a
net or a film having a plurality of pores communicating with an outflow port for a
cleaned filtrate.

Brief Summary Text (20):
[illegible] filter having the aforementioned support
The drawbacks suffered by the [illegible] FIGS. 4(A) and 4(B).
member with ribs will be described with reference to

Brief Summary Text (21):
[illegible] as shown in FIGS. 4(A) and
As is clear from the comparison between [illegible] are determined by the strength of
4(B), the width of and the space between the [illegible] produced by the
the membrane [illegible] inevitable
contact between [illegible] membrane will hinder the
[illegible]. Furthermore, in the case where the
[illegible] cleaned filtrate passing through the
height [illegible] the smaller the space areas, leading
membrane is constant, the larger the pressure loss the smaller the space areas, leading
to an increase in resistance against the flow paths and a possibility of the flow paths
being stopped up.

Brief Summary Text (22):
[illegible] filters have been proposed such as in
On the other hand, disposable pileup type filters have been proposed such as in Japanese Patent Public Disclosure No. [illegible] and Japanese Utility Model Public Disclosure No. [illegible], for example.

Brief Summary Text (23):
In the former Disclosure, as shown in FIG. 6, a support member 31 having a plurality of ribs 31a is prepared by injection molding and two porous membranes 32a and 32b of different shapes immersed in a solvent are attached to the opposite surfaces of the support member 31 respectively to form a unit member. A plurality of such unit members are piled one on top of another at regular intervals to constitute a disposable pileup type filter. Use of the two membranes of different shapes will increase the cost of parts and assembly cost. [illegible] of the solvent to undesirable portions of the membranes 32a, 32b and support member 31 and will also cause an adverse phenomenon, such as clogging of the membranes. Furthermore, the [illegible] membranes 32a and 32b over the entire surfaces of the ribs 31a will [illegible] area of the membranes.

Brief Summary Text (24):
In the latter Disclosure, as shown in FIG. 7, a support member 36 is composed of upper and lower members 36a, 36b of different shapes each having a plurality of ribs. The two members 36a and 36b of different shapes are assembled with a prescribed space formed therebetween into the support member 36 having the upper and lower surfaces which are the same in shape. A pair of porous membranes 32 of the same shape immersed in a solvent are attached to the upper and lower surfaces of the support member 36 to form a unit member. A plurality of such unit members are piled one on top of another with a spacer intervening therebetween on the side of the flow path for a raw fluid. Thus, the assembly of a plurality of unit members into a disposable pileup type filter is cumbersome. While the filter shown in FIG. 6 uses two porous membrane 32a and 32b of different shapes, the filter shown in FIG. 7 uses two members 36a and 36b of different shapes constituting the support member 36. Therefore, the cost of parts and assembly cost will similarly be increased. The [illegible] drawbacks suffered by the filter shown in FIG. 5 still remain in the filter shown in FIG. 7.

Brief Summary Text (25):
In the micro-filtration field, there are hollow yarn type, [illegible] type, pleat type and pileup type modules. In any of these modules, a filter element is of a cartridge and, [illegible] housing for accommodating the filter element, it can serve [illegible] which the housing is made is generally divided into metal and [illegible] depending on various conditions, such as the kind, degree of [illegible], temperature, [illegible] of a fluid.

Brief Summary Text (26):
A filter belonging to the micro-filtration filter which has recently been used in the semiconductor industry requires its fluid flow paths to have smooth surfaces and also requires its housing to have a smooth inner surface. In addition, it is necessary to prevent minute particles of the material of a filter element from being scattered within the housing.

Brief Summary Text [illegible] an inlet portion 41a of [illegible] into the housing 41 and is [illegible] of the housing 41. Since the [illegible] tightly by the use of an O-ring downstream [illegible] can be taken out of the outlet 43 for a gasket, [illegible] On the other hand, the portion 41b without [illegible] For this reason, upstream side 42a of the filter [illegible] the prior art shown in FIG. [illegible] contact with the inner surface of the [illegible] absorbing member 44 [illegible] and that shown in FIG. 9(A) or FIG. tight seal construction on the downstream side 42b, and that shown in FIG. 9(A) or FIG. 9(B) has a ridge 45 or a projection 46 with a [illegible] provided at a position in the vicinity of the inlet portion 41a for the purpose of supporting thereon part of the filter elements 42 on the upstream side 42a.

Brief Summary Text (28):
In the case where the filter elements [illegible] side 42a is not in contact with the inner surface of the housing 41, [illegible] there is a possibility of a seal [illegible] damaged by external impact during the conveyance of the [illegible] being detached from the mounting portion. This will [illegible] In addition, there is a possibility of the [illegible] being detached form the mounting portion by the reverse [illegible]

Brief Summary Text [illegible]
In the case [illegible] interposed between the upstream side 42a of the filter [illegible] of the housing 41 to retain the filter elements [illegible] the problems raised in the prior art of FIG. 7 will be able to be solved. In this case, however, the number of components is increased and, when a fluid is an organic solvent of halide or a strongly acidic or alkaline fluid, for example, it is required to select a proper material for the shock absorbing member 44, thus leading to increase in cost.

Brief Summary Text (30):
In FIG. 9(A) or FIG. 9(B), if the housing 41 is made of synthetic resin, the ridge 45 or projection 46 can be formed with ease by injection molding. When the housing 41 is made of metal, however, mechanical processing including milling and drilling operations is required, thereby inevitably forming [illegible] operation is very cumbersome and brings about increase in [illegible] The formation of such burrs is a serious problem to be solved not only in the [illegible] industry and electronic industry requiring the smoothness of the inner surface of the housing but also in the food industry and chemical industry. When a fluid exhibits high corrosion, the burrs will corrode and be scattered in the form of minute metallic particles which may pass through the filter medium.

[illegible] types are coupled to pipes through couplers, as illustrated in [illegible] by inserting cylindrical coupling portions 47 into the inlet and outlet portions 41a and 41b, welding the inserted cylindrical coupling portions 47 and the inner surface of the housing to form a weld a, and coupling the cylindrical coupling portions 47 to pipes through the couplers. The formation of such weld a will lose the necessary smoothness of the inner surface of the housing.

Brief Summary Text (34):
The object of the present invention is to provide a pileup type filter element of a very simple construction having a plurality of unit members tightly sealed up with and connected to one another in a multilayer form and a method for the manufacture thereof.

Brief Summary Text (35):
Another object of the present invention is to provide a filter element having a possibly smallest area of contact between a support member and a porous membrane which enables the support member to [illegible] the porous membrane thereon and the fluid flow paths to be effectively [illegible] to the recent requirements [illegible]

Brief [illegible]

Still another object of the present invention is to provide a pleat type disposable filter exhibiting a high tight sealing property and making it possible to reduce the cost in component part and assembling parts.

Brief Summary Text (37):
A further object of the present [illegible] filter having a function of [illegible] reverse pressure and being [illegible]

Brief Summary Text (38):
To attain the object [illegible] the present invention there is provided a filter element comprising a plurality of unit members and a plurality of spacers [illegible] the adjacent unit members, each of the unit member [illegible] plate having a pair of planar porous membranes joined to the opposite [illegible] having an opening for insertion of a spacer and removal of a cleaned fluid, the opening having an inner peripheral surface and a stepped part which is formed on the peripheral edge thereof, each of the spacers having an outer peripheral part and a stepped part which is formed on the inner peripheral part thereof, the stepped part of the opening of one of the unit members and the outer peripheral part of one of the spacers defining a first axial seal part therebetween, the inner peripheral surface of the opening of another one of the unit members and the stepped part of said one of the spacers defining a second axial seal part therebetween, the unit members and the spacers being interconnected by tightly joining the supporting plates and the sapcers at the first and second axial seal parts

Brief Summary Text (39):
According to the present invention, there is also provided a method for the manufacture of a filter element comprising the steps of (a) preparing a plurality of unit members and a plurality of spacers being interposed each between the adjacent unit members, each of the unit members comprising a supporting plate having a pair of planar porous membranes joined to the opposite surfaces thereof and also having an opening for insertion of a spacer and removal of a cleaned fluid, the opening having an inner peripheral surface and a stepped part which is formed on the peripheral edge thereof, each of the spacers having an outer peripheral part and a stepped part which is formed on the inner peripheral part thereof, (b) forming a first axial seal part between the stepped part of the opening of one of the unit members and the outer peripheral part of one of the spacers by means of thermal fusion in the axial direction, (c) forming a second axial seal part between the inner peripheral surface of the opening of another one of the unit members and the stepped part of said one of the spacers be means of thermal fusion in the axial direction, and (d) repeating th steps (b) and (c), thereby interconnecting the unit members and spacers at the first and second axial seal parts

Brief Summary Text (40):
Furthermore, according to the present invention, there is also provided a filter element comprising a plurality of unit members, a plurality of spacers interposed one each between the adjacent unit members, and a plurality of gaskets, each of the unit members comprising a supporting plate having an opening for removal of a cleaned fluid and a pair of planar porous membranes of thermoplastic synthetic resin of the same shape joined in an overlapped state to each other at their respective outer edges and enclosing the supporting plate, each of the gaskets having one surface thereof attached to the surface of the planar porous membrane and the other surface thereof attached to the surface of the spacer with a solvent at a position in the vicinity of the opening of the supporting plate, the unit members and the spacers being interconnected at the gaskets.

Brief Summary Text (41):
[illegible] there is provided a micro filtration [illegible] tube parts inserted into the [illegible] into the interiors of the opposite ends of the upper and lower [illegible] annular depressions formed by projecting [illegible] housings to give [illegible] tube parts, a filter element parts of the housings [illegible] tube parts, a filter element accommodated within the housings, [illegible] having a flow path, having one end thereof inserted into one of the projected tube parts and disposed on the upstream side of the filter element, and an O ring for attaching the other projected tube part on the downstream side of the filter element to the corresponding annular depression.

Drawing Description Text (2):
FIG. 1 is an explanatory perspective view illustrating a prior art pleat type filter.

FIG. ... illustrating a prior art pileup type filter.

Drawing Description Text:
FIG. 3 is a ... illustrating a prior art filter element.

Drawing Description Text:
FIG. 7 is a partially cutaway ... illustrating a prior art filter.

Drawing Description Text:
FIG. 8 is a cross section illustrating another prior art filter.

Drawing Description Text:
FIGS. 9(A) and 9(B) are cross-sectional views illustrating further prior art filters.

Drawing Description Text (12):
FIG. 11 is a cross section illustrating ... of a filter element according to the present invention.

Drawing Description Text (14):
FIGS. 12 and 13 are a partially cutaway plan view and a cross section respectively illustrating ... of a supporting plate usable for the filter element.

Drawing Description Text:
FIGS. 14 and 17 are a partially cutaway plan view and a cross section respectively illustrating another example of a supporting plate usable for the filter element.

Drawing Description Text (17):
FIGS. 20 to 23 are explanatory cross-sectional views illustrating processes for manufacturing the filter element.

Drawing Description Text (2):
FIG. 26 is a cross section illustrating another embodiment of the filter element according to the present invention.

Drawing Description Text (21):
FIGS. 27 an 28 are a partially cutaway plan view and a cross section respectively illustrating one example of a supporting plate usable for the filter element of FIG. 26.

Drawing Description Text:
FIG. 31 is a cross section illustrating still another embodiment of the filter element according to the present invention.

Drawing Description Text (24):
FIG. 32(A) is an exploded perspective view illustrating porous membranes, a supporting member and a spacer used in the filter element of FIG. 31.

Drawing Description Text (26):
FIGS. 33 to 40 are cross-sectional views illustrating further embodiments of the filter element according to the present invention.

Drawing Description Text (27):
FIG. 41 is a cross section illustrating one embodiment of a micro-filtration filter according to the present invention, accommodating therein the filter element of FIG. 33.

Drawing Description Text (28):
FIG. 42(A) is an exploded perspective view illustrating a supporting member used for the filter element of FIG. 33.

Drawing Description Text:
FIG. 42(C) is an exploded perspective view illustrating the filter element of FIG. 33.

Drawing Description Text:
FIG. 43 ... view illustrating another embodiment of the micro-filtration filter according to the present invention.

Drawing Description Text

FIG. 44 is a [illegible] filter of FIG. 43.

Drawing Description Text [illegible]
FIG. 45 is a perspective view [illegible] micro-filtration filter of FIG. 44.

Detailed Description Text [illegible]
FIG. 11 is a [illegible] constructed [illegible]

[illegible] supporting plates 52 are formed projected parts [illegible] planar porous membranes 50 and forming flow 51a which [illegible] constructed by tightly joining paths for a cleaned fluid [illegible] outer circumferential edge parts the porous membranes 5[illegible] with [illegible] FIG. 13, also to circumferential 53 of the supporting plates 52 and, as illustrated in FIG. 13, also to circumferential edges 56a and 56b of openings 56 for insertion of annular spacers 54 and for removal of a cleaned fluid.

Detailed Description Text [illegible]
The unit or filter members 57 and the spacers 54 interposed one each between the adjacent unit members 57 are interconnected by tightly joining the supporting plates 52 and the spacers 54 at the positions of first seal parts 59 and second seal parts 58 by means of thermal fusion.

Detailed Description Text (17):
In a filter which is produced by [illegible] capable of infallibly removing minute particles [illegible] highly reactive fluid [illegible] supporting plates, when all the members exposed [illegible] fluorine resin [illegible] fluorine resin copolymer, simple and safe fusion of the unit members of the laminate has been attained only with difficulty [illegible] type resin possesses chemical and thermal stability [illegible] compared with other general purpose resin. In accordance with the present invention, the parts subjected to fusion can be joined by simultaneous application of heat and pressure without requiring any special device designed exclusively for fusion or without being affected by the construction peculiar to the laminate. In the laminate of this invention, therefore, the sealing can be attained easily with notably heightened accuracy as compared with the conventional laminate.

Detailed Description Text (18):
Even when all the parts to be exposed to a fluid are made of a fluorine type resin which is both chemically and thermally stable, therefore, the laminated filter contemplated by this invention can be produced in a compact structure containing highly reliable sealed parts.

Detailed Description Text (20):
Now, another typical filter element composed of planar porous membranes and supporting plates will be described below with reference to FIGS. 41 and 42 as another embodiment of this invention.

Detailed Description Text (21):
The filter element is constructed by joining planar porous membranes 5[illegible] one each to the opposite surfaces of supporting plates 52 along the circumferential edges thereof, [illegible] these unit members 57 through the [illegible] projected parts [illegible]. A multiplicity of projections [illegible] supporting plates 52 for contact with the [illegible] for contact with the prous membranes, porous membranes [illegible] with an outlet flow path 55 of the filter convergent orifices 51a and [illegible] are intended to establish communication element are formed. The convergent orifices [illegible] supporting plates 52 and are disposed as radially between the opposite surfaces of the supporting plates [illegible] along the circumference of the arranged. The convergent orifices [illegible] directly connected to the outlet flow path outlet flow path 55 of the filter and are directly connected to the outlet flow path 55. The projected parts 51d formed near the convergent orifices 51b and 51c are larger than the projections 51a mentioned above. The total of the surface areas of the openings of these convergent orifices 51b and 51c must be at least equal to the surface area of the outlet flow path 55 of the filter in one unit member 57. When the convergent orifices 51b and 51c are formed in a circular shape, their diameters must be at least [illegible] mm because of the [illegible] injection molding. In the present embodiment, the [illegible]

shape. When the [illegible] in diameter and [illegible] mm in height are disposed one each at the [illegible] of an equilateral triangle of 1.4 mm, the convergent orifice 5.b cannot be [illegible] disposed [illegible] the boundaries of the projections 51a. When one convergent orifice [illegible] the projections 51a at all, the projections 51a surrounding the convergent orifices 51b are required to possess a diagonal distance of [illegible] mm. In this case, the porous membrane [illegible] in proportion as the inflow pressure [illegible], with the result that the empty space layer in the flow path is decreased [illegible] of the flow path. This phenomenon becomes conspicuous in proportion as the porous membrane loses its nerve. Even while the inflow pressure is constant, the flow volume continues to decrease with the elapse of time. The flow rate eventually reaches a fixed level. Thus, the projected parts 51d disposed around the convergent orifices 51b are formed in larger dimensions of 1.[illegible] mm in diameter and [illegible] mm in height. The increased dimensions serve the purpose of precluding the [illegible] of the flow path due to the stretching of the porous membrane and ensuring [illegible] flow volume properties in spite of an increase in the inflow pressure. [illegible] formed in the central part of the convergent [illegible] the stability with which the flow volume properties are retained. The projections 51a and the projected parts 51d formed on the supporting plates 52 are disposed after the pattern of equilateral triangles [illegible] and these projections 51a and projected parts 51d are [illegible] in the shape of a hemisphere or a circle. It has been confirmed that [illegible] .5 to 10 times the diameter of the [illegible] parts 51a have a diameter [illegible] and a height in the range of 0.2 to 2 mm. The planar opening of the [illegible] porous membranes [illegible] of a polymer film having an orifice diameter in the range of 0.01 to [illegible] than 2% and a thickness in the range of 50 to 2[illegible] microns. The material of the polymer film may be freely selected to suit the particular application for which the laminated filter is used. Examples of the material include tetrafluoroethylene, cellulose acetate, cellulose nitrate, polypropylene, polyvinyl alcohol, polyamide, polymethyl methacrylate, polysulfone, polyether sulfone and polyvinyl chloride.

Detailed Description Text (23):
A cleaned fluid which has passed through the planar porous membranes 50 supported with the projections 51a and the projected parts 51d, namely hemispherically or circularly protuberant ribs, formed on the surfaces of the supporting plates 52 for contact with the porous membranes finds its way through the flow paths or empty spaces formed by the projections 51a and the projected parts 51d jointly with the porous membranes 5[illegible] to the convergent orifices 51b communicating with the outlet flow path [illegible] of the filter. The cleaned fluid departs from the laminated filter through the outlet flow path 55 of the filter

Detailed Description Text ([illegible]):
[illegible] this invention contemplates giving a [illegible] near the convergent orifices than to the [illegible] with the increase in the inflow pressure, it enjoys the advantage that the contact areas between the supporting plates and the membranes are minimized, the membranes are prevented from being warped and are allowed to retain the flow volume properties stably, and the filter is enabled to pass the fluid under treatment in a high flow volume and consequently allowed to be produced in a compact structure. Thus, the filter element offered by the present invention enjoys very high practical utility.

Detailed Description Text (27):
Since the recent semiconductors are tending toward augmentation of both density and integration, the carrier gas, etching gas, purging gas and other processing gases used in the production of semiconductors require use of a filter which is endowed with a high capacity for cleaning and an ability to lower the pressure loss to the largest possible extent. This invention can provide a filter which satisfies the requirement infallibly.

Detailed Description Text ([illegible]):
FIGS. 3[illegible] to 42 [illegible] laminated filter as yet another embodiment [illegible] of the total filtration type [illegible] a cross section of a [illegible] and [illegible] a cross section of a [illegible] type.

Detailed Description Text ([illegible]):
In the diagrams, planar porous membranes [illegible] possess countless continuous through pores

[illegible] The porous having the diameter approximately [illegible] in the final filtration membranes 81 in the present embodiment [illegible] filtrate type of FIG. 33, an [illegible] opening part [illegible] is bored in the central part. In [illegible] parts 81b and [illegible] and right half areas and [illegible] in the central part. Two porous membranes 81 [illegible] one on top of the other through the medium [illegible] interposed [illegible] by fusing these porous membranes [illegible] thereof, except for the portions [illegible] by means of a hot press, for example. A laminate [illegible] of filter units 83 [illegible] provided with an opening part 84a and through the medium of [illegible] further with a ribbed surface and, at the same time, [illegible] them with a small amount of solvent to annular gaskets 85 formed integrally with or independently of the spacers 84 and the outer surfaces near the outlet opening parts of the porous membranes 81 for discharge of the cleaned fluid.

Detailed Description Text (31):
The supporting plates 82 or the spacers 84 can be easily obtained by punching relatively inexpensive materials such as porous materials like meshed fabric, non-woven fabric and woven fabric formed by a [illegible] molding method more productive than injection molding or sheets of uniform surface irregularities formed by injection molding, for example.

Detailed Description Text (33):
The spacers 84 are provided with gaskets 85 formed integrally therewith or independently thereof. In the present embodiment, the spacers 84 are provided with separate gaskets [illegible] the spacers 84. The [illegible] opening parts formed in the [illegible] the cleaned fluid ensures the perfectness of the [illegible] Generally, when synthetic resin materials are mutually joined with adhesive agent, the solvent selected for the union is required to possess compatibility with the separate materials being joined. In the present embodiment, this general principle does not apply to the fusion of the porous membranes 81 with the adhesive.

Detailed Description Text (36):
A filter 97 is completed by accommodating in upper and lower housings 95 and 96 the laminate 86 and the protective members [illegible] at the opposite ends of the laminate 86 in the axial direction of lamination. To be specific, the filter 97 is assembled, as illustrated in FIG. 41, by combining an outlet part 95a of the upper housing 95 with the outlet 90 of the protective member 87 through the medium of an O-ring 100 and then coupling the upper housing 95 with the lower housing 96 which possesses an outlet part 96a and a projection 96b.

Detailed Description Text (37):
Now, the operation of the preceding embodiment will be described below. Since each two identically shaped porous membranes [illegible] so as to embrace therein one intervening supporting plate 82, the porous membranes 81 are retained stably enough to resist the pressure of filtration and are enabled to give rise to flow paths for [illegible] filter unit 83 is formed by fusing the circumferential [illegible] porous membranes 81 except for the portions [illegible] opening parts 81a of the porous membranes for release of the cleaned fluid, the filter units 83 can be easily assembled so as to manifest the sealing effect permanently. Further, since a multiplicity of filter units 83 are superposed through the medium of intervening spacers 84, they attain effective retention of the flow path for the raw fluid and offer perfect resistance to the back pressure possibly exerted from the cleaned fluid side. The laminate 86 is completed by causing the gaskets 85 disposed integrally with or independently of the spacers 84 to be joined with adhesive agent to the outer surfaces near the outlet opening parts of the porous membranes 81 for the release of the cleaned fluid. Thus, the process of assembly can be simplified and, at the same time, the otherwise possible mingling of the cleaned fluid with the raw fluid can be efficiently avoided, with the result that microorganisms or minute particles entrained by the liquid or gaseous raw fluid can be separated infallibly and then released safely through the outlets.

Detailed Description Text (41):
A finished product similar [illegible] can be obtained by

accommodating in the upper and lower [illegible] the laminate [illegible] and the protective
members 57 and [illegible] disposed at the [illegible] of the laminate in the axial direction
of lamination.

Detailed Description Text [illegible]
For example, this invention [illegible] planar porous membrane laminated filter
satisfying all the [illegible] to be produced from
inexpensive parts at a low cost [illegible].

Detailed Description Text [illegible]
To be more specific, as sealing means for the prevention of the otherwise possible
mingling of the cleaned fluid with the raw fluid, the adjacent membranes are joined by
thermal fusion and the gaskets and the [illegible] are joined by adhesion with a
small amount of solvent. Thus, the laminated filter [illegible] and reliable sealing
with ease.

Detailed Description Text [illegible]
[illegible] and the gaskets are formed by continuous molding
[illegible] they can be formed with walls of small thickness and
[illegible] in a compact structure.

Detailed Description Text [illegible]
FIGS. 43 to 45 illustrate a typical micro-filtration filter as a further embodiment of
the present invention. FIG. 43 is a front view of the micro filtration filter, FIG. 44
a longitudinal cross section taken through FIG. 43, and FIG. 45 a perspective view of a
filter element as taken from the upstream side.

Detailed Description Text [illegible]
As unit members 57 for accommodation in the upper and lower housings 111 and 112,
planar porous membrane laminated filter elements are used in the present embodiment.
The filter elements will be described below with reference to FIG. 44. A multiplicity
of flow paths 110a are formed on disk-shaped supporting plates 52. Planar porous
membranes 50 are used one each for covering the obverse and reverse surfaces of the
supporting plates 52. The supporting plates 52 and the annular spacers 54 are
sequentially superposed. The central flow path [illegible] formed in the central part of the
spacers 54 are caused to communicate with the flow paths 110a. Further, the central
flow path 55 is caused to communicate with outlet tube parts 118. The retaining plates
113 on the upstream side of the unit members 57 are provided with projected parts 115
possessing a flow path 114. Inserting stepped parts 116 formed at the leading ends of
the [illegible] are inserted into the projected tube parts 105 mentioned above
and [illegible] formed on the retaining plates 117 on
the downstream side of the unit members 57 are fitted into the annular depressions 107
through the medium of the O-rings [illegible] and the projected tube parts 106 are tightly
fitted into the outlet tube parts 118.

Detailed Description Text [illegible]
The upper and lower housings 111 and 112 are perfectly identical in structure and they
are butt welded to encase the unit members 57. All the parts of which the unit members
57 are formed are made of fluorine resin or fluorine resin copolymer. The planar porous
membranes 50 are films of fluorine resin or fluorine resin copolymer having a pore
diameter in the range of 0.01 to 5 microns, a porosity of not less than 20% and a
thickness in the range of 50 to 200 microns. Otherwise, the planar porous membranes 50
may be made of a polymer suitably selected from among cellulose acetate,
nitrocellulose, polyamide, polyvinyl chloride, polyvinyl alcohol, polymethyl
methacrylate, polysulfone and polyester [illegible]. In this case, the other components of
the elements may be formed of a material which is not limited to fluorine resin or
fluorine resin copolymer but is suitably selected from among various materials.

Detailed Description Text [illegible]
The fluid to be cleaned which has flowed in [illegible] the connection tube part 104 on the
inlet side of the lower housing 112 passes through the flow paths 114 of the projected
parts [illegible] and disperses itself in the empty
space [illegible]. The portion of the fluid which has
[illegible] the primary pressure exceeding the membrane
resistance [illegible] the outlet tube parts 118 on the downstream
side of the unit members [illegible] the outlet side of the
connection tube parts [illegible] of the housing 111, permitting
efficient production of a cleaned fluid. In this case, since the outlet tube parts 118
are fitted in the annular depression [illegible] the medium of the O-rings 119 and, at

[illegible] parts [illegible] the same time, [illegible] the flow paths [illegible] against each other [illegible] the filter the shrinkage [illegible] of this [illegible]

[illegible] the filter elements disposed The filter [illegible] sealing on the downstream inside the housing [illegible] Further, the filter of this side of the filter [illegible] compared with the invention enjoys notably [illegible] effect in the sense that conventional filters. This [illegible] the filters thereof can be [illegible]

CLAIMS:

1. A method for the manufacture of a filter element comprising the steps of:

(a) providing a plurality of unit members and a plurality of spacers, each of said unit members being composed of fluorine [illegible] resin copolymer and comprising a supporting plate having a pair of [illegible] to the opposite surfaces thereof and having an opening [illegible] and removal of a cleaned fluid, said opening [illegible] and a stepped part formed on the peripheral edge thereof, each [illegible] being composed of fluorine resin or fluorine resin copolymer and having an outer peripheral part and a stepped part formed on the [illegible] peripheral part thereof,

[illegible] part between said stepped part of said opening of one of said [illegible] peripheral part of one of said spacers by means of thermal fusion in the axial direction,

(c) forming a second axial seal part between said inner peripheral surface of said opening of another one of said unit members and said stepped part of said one of said spacers by means of thermal fusion in the axial direction, and

(d) repeating the steps (b) and (c) using other ones of said unit members and spacers to thereby interconnect said unit members and spacers at said first and second axial seal parts to form a filter element.

[illegible] A method of manufacturing a filter assembly comprised of axially stacked filter members separated by spacers, comprising the steps of: providing a plurality of filter members composed of thermally fusible [illegible] resin copolymer material, each filter member having an opening [illegible] defined by a stepped wall having radially inner and outer circumferential wall [illegible]; providing a plurality of spacers composed of thermally fusible fluorine resin or fluorine resin copolymer material, each spacer having an outer circumferential wall surfaces; axially inserting a first spacer in the opening of a first filter member with the spacer outer circumferential wall surface opposed from and facing the filter member outer circumferential wall surface and thermally fusing together the opposed wall surfaces to [illegible] therebetween; axially inserting a second filter member onto the [illegible] inner circumferential wall surface opposed [illegible] circumferential wall surface and thermally from and facing the [illegible] spacer inner [illegible] a fluid-tight seal therebetween; and fusing together the opposed wall [illegible] steps using other ones of the spacers successively repeating both inserting and fusing steps using other ones of the spacers and filter members to form a filter assembly comprised of axially stacked filter members separated by spacers.